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Incorporation of selected millets in development and standardization of value added products

Syea Tasbiha Rajin[1], Radali Duarah[*1], Angkita Mishra[2]

[1]*Programme of Food, Nutrition and Dietetics, Assam down town University, Guwahati, (Assam), India*

[2]*Home Science, Department of Vikriti Vigyan, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Uttar Pradesh, India*

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Abstract

Millet, the super food, was once a crucial part of the Indian diet but lost its importance over time. It has superior nutritional qualities and has the potential to serve as an alternative staple food. The study focused on utilizing ragi, foxtail and proso millet to create value-added products due to their nutritional richness and accessibility. Foxtail and finger millets are known for their abundant micronutrients, macronutrients, antioxidants, and nutraceutical properties. Proso millet stands out for its superior nutritional content compared to common cereals, featuring higher mineral, fibre, vitamin, and amino acid levels. The research aimed to promote economic growth and innovation in the food sector by diversifying products. Composite flour combining these millets was employed to craft *Bor Pitha*, *Murukku*, noodles, and *Burfi*. Different millet ratios (100%, 70%, 60%, 50%) were used in each product alongside besan and urad dal flour. Composite flour analysis showed 8.61% moisture, 0.82% ash, 8.38% protein, 2.43% fat, 79.02% carbohydrates, and 370.392 kcal/100g energy. Individual millet flours mirrored previous findings. Sensory evaluations with a semi-trained panel of thirty members assessed the colour, appearance, taste, texture, flavour, and overall liking of the prepared products via a nine-point hedonic scale. Product acceptability scores varied across formulations, indicating preferences. In conclusion, the study successfully developed and standardized value-added products using chosen millets, showcasing their nutritional benefits for improved health, food security, and sustainable agriculture. Sensory evaluations provide valuable insights for refining and commercializing the products which may act beneficial towards boosting the local economy.

***Corresponding Author:** Radali Duarah ✉ radali.duarah@adtu.in

Introduction

Food holds significant cultural significance and is imbued with diverse meanings and symbolisms across different age groups. It should not only be nutritious but also appealing in taste and appearance to be savoured and enjoyed by individuals (Jyoti *et al*., 2022). In the 97th episode of Mann ki Baat, it was emphasized by the Hon'ble Prime Minister that" "India is the largest producer of Millet in the world and therefore, the responsibility of making this initiative a success also rests on the shoulders of Indians". He said it has to be made into a mass movement, and awareness of Millets among the people of the country should also be increased (Londhe and Gundeti, 2023). Orphan crops, such as cereals, legumes, vegetables, and tubers, play a crucial role in ensuring food security and supporting the livelihoods of resource-constrained farmers and consumers in Asia and Africa (Tadele, 2019). Millets are a nutritious and versatile wonder grains (Mishra and Chandolia, 2023).

The term "millet" encompasses a group of small-seeded annual grasses belonging to five genera: Panicum, Setaria, Echinocloa, Pennisetum, and Paspalum, which are part of the Paniceae and Eleusine tribes in the Chloridoideae subfamily (Biradar *et al*., 2023). Millet is referenced in the Bible and was utilized during ancient times for making bread (Choudhari and Khan, 2023). Millets possess superior nutritional qualities compared to rice and wheat, as they are rich in vitamins, iron, carbohydrates, calcium, potassium, zinc, phosphorus, magnesium, and essential amino acids, making them a highly beneficial dietary choice (Maharajan *et al*., 2021). As native grains in various countries, including India, millets have the potential to serve as an alternative staple food, addressing challenges such as water scarcity, desertification, global warming, and carbon footprint management (Mishra and Chandolia, 2023).

One of the most nutrient-dense of all major cereals, finger millet has been dubbed a potential "Super Cereal" by the American National Academies (Hymavati, 2019). Finger millet serves as a staple food in developing countries and as animal feed in developed nations, reflecting its status as a "poor man's food" due to its affordability and versatility (Wambi *et al*., 2020). In the local language of Assam, it is known as "Marua" (NEH Report-33rd AGM, 2022). Finger millet, holds significant importance among the various millet varieties. It is extensively cultivated in Asia and Africa, where it serves as a staple food for many populations in these developing regions. The cultivation of finger millet is prevalent due to its adaptability to diverse environmental conditions, including areas with limited rainfall or poor soil quality. This resilient crop plays a crucial role in ensuring food security and sustenance for communities in these regions (Xian, 2019). Foxtail millet, a versatile grain, is characterized by small, ovoid-shaped grains that range in color from pale yellow to orange, red, brown, or black. It is known as Konidhan in Assam (NEH Report-33rd AGM, 2022). De-hulling is necessary to utilize the grain as food since it is enclosed in thin hulls. The grains have a lengthy shelf-life and can be cooked whole, similar to rice, or ground into meal. It offers nutritional value that is comparable to, and in some aspects even superior to, staple cereals like rice and wheat. Various culinary preparations such as upma, pulao, khichdi, and biriyani can be made from foxtail millet. Additionally, it can be consumed as porridge or transformed into leavened bread (roti) after milling the de-hulled grain into flour. Its moderate glycaemic index and high fibre content contribute to slower sugar release in the bloodstream, making it beneficial for preventing diabetes and cardiovascular disease (Hariprasanna, 2023). In addition, it offers nutritional value that is comparable to, and in some aspects even superior to, staple cereals like rice and wheat. Foxtail millet, a type of annual grass plant known as Setaria italica, produces seeds that are beneficial for health due to their unique protein composition. These seeds are rich in essential amino acids, making them a valuable source of nutrition. The distinct protein profile contributes to the nutritional value of foxtail millet, making it an appealing choice for those seeking a protein-rich

dietary option (Sachdev *et al.*, 2020). Panicum miliaceum, a common and significant minor millet in the family Gramineae, is known as proso millet. It is also known as common millet (Nutritional and Health Benefits of Millets, 2017). The grains of proso millet are a rich source of vitamins, minerals, essential amino acids, starch, phenolic compounds, and antioxidants (NEH Report-33rd AGM, 2022). Proso millet, rich in nutrients and phytochemicals such as flavonoids and phenolic compounds, exhibits various physiological properties including antioxidant, hypoglycemic, hypolipidemic, and anti-cancer effects, with potential for preventing cardiovascular disease, type 2 diabetes, cancer, and obesity (Xiang *et al.*, 2023).

Assam, the gateway to North East India, is renowned for its unparalleled biodiversity, attributed to its distinctive geo-edaphic and agro-ecological characteristics (Gogoi *et al.*, 2022). In Assam and other north-eastern states, Finger Millet (Eleusine coracana), locally known as "Marubadhan," is commonly grown during the Kharif season.. During the Rabi season, farmers in the region cultivate Foxtail Millet (Setaria italica), known as "Cawn" (NEH Report-33rd AGM, 2022). In line with this, the Government of Assam has launched the Assam Millets Mission (AMM) for a duration of seven years, starting from 2022-23. The AMM aims to support and advance millet cultivation in Assam. There has been a slow but noticeable increase in production and productivity of millets from 2008 to 2015. In Assam, millets are predominantly cultivated by tribal and Siaothali farmers for preparing local wine, pithas (chapatti), and laddu, while Muslim community farmers in "char" areas focus on millet cultivation for both personal consumption and commercial purposes. The grains are traditionally dehusked using a locally utilized device called dhenki (NEH Report-33rd AGM, 2022).

One of the primary challenges faced by nutritionists is alleviating human suffering caused by nutritional stress, particularly in India where the population experiences food and nutritional insecurity. To overcome the challenges and promote millet consumption, one possible strategy is to incorporate them into composite mixes by blending them with other ingredients in an acceptable manner (Vudugula *et al.*, 2018). Sweets possess an essential role in diet, it also important part in traditional offering, socioeconomic culture and most importantly in festivals. Sweets like Malpua/pitha, burfi are prepared on festivals like Hariyali Amavasya, (Jain, 2020) Durga puja, Kali Puja, Makar Shankranti, Rajo, Dewali, Ratha Yatra Sasthi, Dola Purnima and Bihu etc. (Kumari *et al.*, 2022), (Neog, 2021). Dough or batter is used in making pitha by steaming, griddling, frying. It can be savory or sweet. Flavouring agents such as cardamom or camphor are generally used. Pitha has its origin in Indian subcontinent. It is similar to pancakes and fritters (Kumari *et al.*, 2022). Burfi is a milk-based confection, generally made of khoa. Along with khoa nuts, pulses etc are used for higher acceptability (KD *et al.*, 2022). At room temperature, it has a shelf life of 7 to 10 days (Baburao *et al.*, 2019). Murukku is made using rice and urad dal flour. It is a cuisine of Tamil Nadu, Kerala of India and Sri Lanka. It is also called chakli in western India which is made from Bengal gram flour (Namitha *et al.*, 2019).

The pioneer of noodles was China as early as 5000 BCE (Parvin *et al.*,). Throughout the world, noodles are consumed because of its lower cost, ease of cooking, longer shelf life (Hymavati, 2019) and excellent sensory properties. In Asia it a major traditional cereal based product (Li *et al.*, 2020). Over the past three decades, the direct consumption of millets as food has significantly declined, despite their nutritional benefits. This decline can be attributed to several factors, including a lack of awareness regarding their nutritional qualities, difficulties in food preparation, inadequate processing technologies, and government policies that hinder millet promotion while favouring subsidized prices for refined cereals. Additionally, the unavailability of processed millets in convenient ready-to-use forms presents another obstacle to their utilization (Vudugula *et al.*, 2018). The development of value-added products incorporating selected millets is justified for several

reasons. Firstly, millets are highly nutritious grains rich in essential minerals, fibre, and antioxidants, which can contribute to improving public health and addressing malnutrition. Secondly, millets are climate-resilient crops requiring less water and inputs, making them environmentally sustainable. Developing value-added products with millets can increase their utilization and market value, thereby benefiting farmers and promoting agricultural diversification. Lastly, these products can cater to the growing demand for healthier and sustainable food options, contributing to the overall well-being of consumers and the planet. Proso, foxtail, and finger millet are of paramount importance in the diet as they provide essential nutrients, contribute to food security, and promote sustainable agriculture, thereby positively impacting. The economy through improved health outcomes and increased agricultural productivity. Therefore, to ensure proper utilization of these functional foods, thereby fostering economic development through diversification and innovation in the food industry the present study was undertaken with an aim to prepare value-added products with the incorporation of millet mix powder and to assess their organoleptic quality. This study was undertaken with the aim to develop value-added products incorporating composite millet flour and to evaluate the shelf life of the developed products.

Material and methods

In the present study, the raw materials were first procured and pre-processed for making them ready to use. Their proximate compositions were then analysed and various products were prepared using them. A sensory evaluation of these products was done and their shelf-life was also studied. The data received were then statistically analysed for better understanding.

Sample selection

For the present study proso millet, finger millet and foxtail millet were selected due to their easy availability and high nutritional value. Apart from millet, other key ingredients such as besan, and urad dal flour, were also selected.

Procurement of raw material

Proso millet, finger millet and foxtail millet were procured from the Ganeshguri local market of Guwahati, Assam. Other ingredients like besan flour, urad dal flour, refined wheat flour, peanut etc. were procured from the local stores of Guwahati, Assam.

Pre-processing of raw materials

For the development of composite flour, equal amounts of the three millets, i.e., finger millet, proso millet, and foxtail millet, were pre-processed into flour prior to the formulation of the composite mix and were stored in an air-tight container.

Preparation of finger millet flour

Finger millet was cleaned, washed and sun-dried for 5 hours after which it was ground in a mechanical grinder. The powder was then sieved in a mesh to obtain a homogeneous flour. Fig. 1 shows the flow diagram of processing finger millet flour.

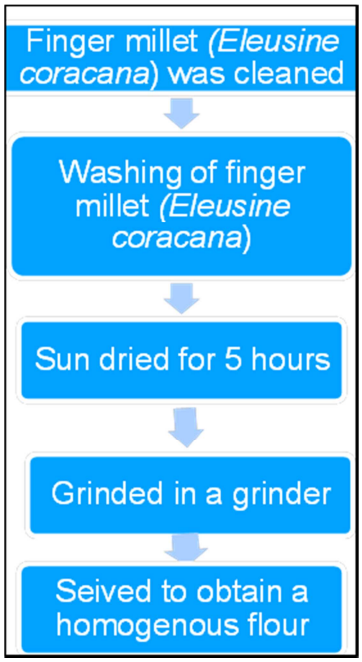

Fig. 1. Flow diagram of processing finger millet flour.

Preparation of proso millet flour

Proso millet was cleaned, washed, sun-dried for 5 hours and then ground in a mechanical grinder. The dried powder was then sieved in a mesh to obtain a homogeneous flour. Fig. 2 shows the flow diagram of processing proso millet flour.

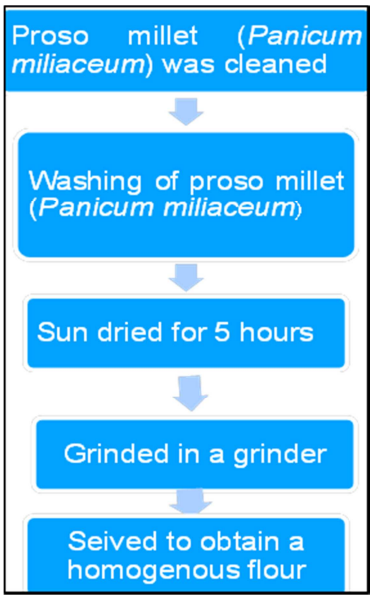

Fig. 2. Flow diagram of processing proso millet flour.

Preparation of foxtail millet flour

Foxtail millet was cleaned, washed, and sun-dried for 5 hours and then ground in a mechanical grinder. The dried sample was then sieved in mesh to obtain a homogeneous flour. Fig. 3 shows the flow diagram of processing foxtail millet flour.

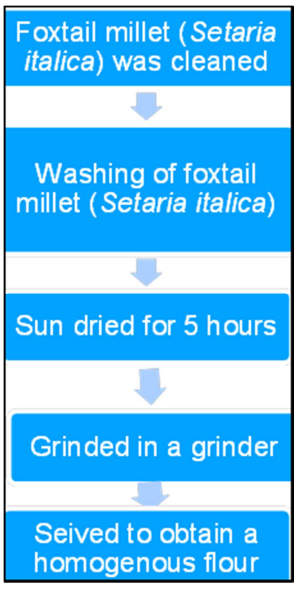

Fig. 3. Flow diagram of processing foxtail millet flour.

Preparation of composite flour

The finger millet flour, proso millet flour and foxtail millet flour were added in equal amounts, i.e. 33.33% to obtain the composite flour. Fig. 4 shows the flow diagram of processing composite millet flour.

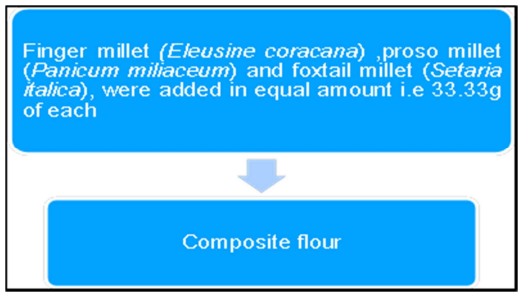

Fig. 4. Flow diagram of processing composite flour.

Proximate analysis of formulated composite mix

Proximate analysis of the prepared homogenous flour was done by using standard AOAC methods.

Formulation of composite flour products

Four different products were formulated by using pre-prepared composite flour.

Formulation of Bor Pitha

Four variations of *bor pithas* namely, M1P1, M2P2, M3P3, and M4P4 were formulated using the composite flour as a base ingredient**.** The table 1 shows the formulation of the variations and Fig. 5 shows the methodology for preparation of the *Bor Pitha.*

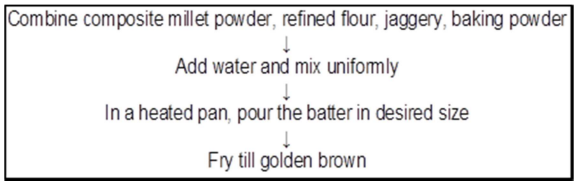

Fig. 5. Methodology for preparation of the *Bor pitha.*

Table 1. Formulation of variations for pitha.

Ingredients	M1P1	M2P2	M3P3	M4P4
Composite millet flour (g)	100	60	50	40
Maida (g)	0	40	50	60
Jagerry (g)	26	26	26	26
Water (ml)	110	90	90	90

Formulation of Burfi

Four variations namely, M1B1, M2B2, M3B3, and M4B4 were formulated using the composite flour as the base ingredient. The following table below shows the composition of the different variations.

Table 2 shows the formulation of the variations and Fig. 6 shows methodology for preparation of the Burfi.

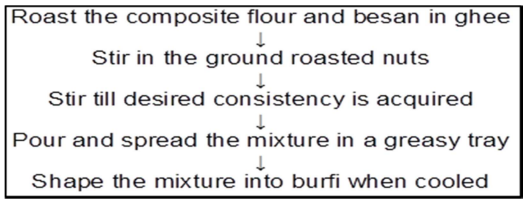

Fig. 6. Methodology for preparation of the *Burfi*.

Table 2. Formulation of variations for burfi.

Ingredients	M1B1	M2B2	M3B3	M4B4
Composite millet flour (g)	100	70	60	50
Besan (g)	0	30	40	50
Sugar (g)	110	110	110	110
Ghee (ml)	200	200	200	200

Formulation of Murruku

Four variations namely, M1M1, M2M2, M3M3, and M4M4 were formulated using the composite flour as the base ingredient. Table 3 shows the formulation of the variations and Fig. 7 shows the various methodology for the preparation of the murukku.

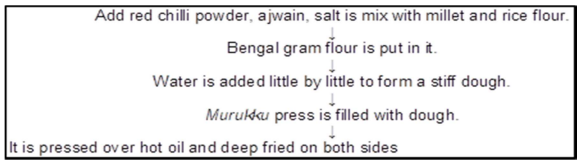

Fig. 7. Methodology for preparation of the *Murukku*.

Table 3. Formulation of variations for murruku.

Ingredients	M1M1	M2M2	M3M3	M4M4
Composite millet flour (g)	100	50	60	70
Urad dal flour (g)	0	50	40	30
Rice flour (g)	0	10	10	10
Oil (ml)	5	5	5	5
Water (ml)	85	65	65	65

Formulation of Noodles

Four variations namely, M1N1, M2N2, M3N3, and M4N4 were formulated using the composite flour as a based ingredient**.** table 4 shows the formulation of the variations and Fig. 8 shows the methodology for the preparation of the noodles.

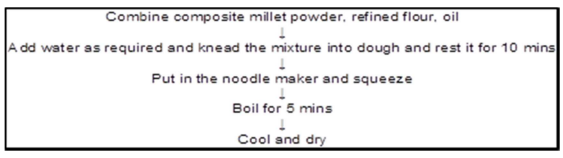

Fig. 8. Methodology for preparation of the *Noodles*.

Table 4. Formulation of variations for noodles.

Ingredients	M1N1	M2N2	M3N3	M4N4
Composite millet flour (g)	100	70	60	50
Maida (g)	0	30	40	50
Oil (ml)	5	5	5	5
Water (ml)	60	50	50	50

Sensory evaluation of composite flour products

A scientific field known as sensory assessment is used to elicit, measure, analyse, and interpret responses to food and material features as they are experienced by the senses of sight, smell, taste, touch, and hearing.

Formulation of scorecard

The scorecard method was chosen to assess the acceptability of the produced formulations. A scorecard is a tabulated list of sensory attributes contributing towards the quality of a product with a numerical value assigned to each attribute. In the present study, a scorecard was made consisting of a table utilizing the Hedonic ratings of a nine-point scale from like extremely to dislike extremely. The qualities taken into consideration were colour, appearance, taste, texture, flavour and overall acceptability. The Hedonic rating test was used to measure the consumer acceptability of food products where one to five samples of each product are served to the panellist at one session and asked to rate the product.

Selection of Panels

For the sensory evaluation of the products of composite flour 30 semi-trained panellists of the age group between 20-40 were selected, from different departments of the Faculty of Science, Assam downtown University. These members were willing to cooperate and gave time for judging and scoring the products. The food samples were prepared in identical sample containers and each sample was presented with a different number. Panellists were asked to evaluate the coded samples for each sensorial parameter including colour, appearance, taste, texture, flavour and overall acceptance based on their degree of liking (1= dislike extremely, 2 =dislike very much; 3 = dislike moderately; 4 = dislike slightly, 5 = neither like nor dislike; 6= like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely).

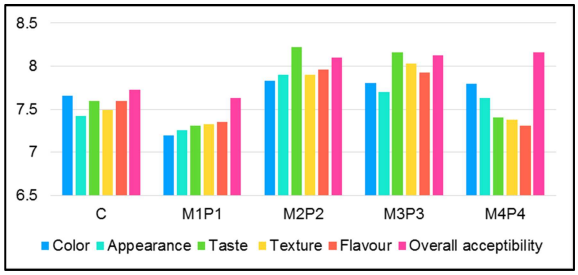

Fig. 9. Graph representing mean acceptability for *Bor pitha*.

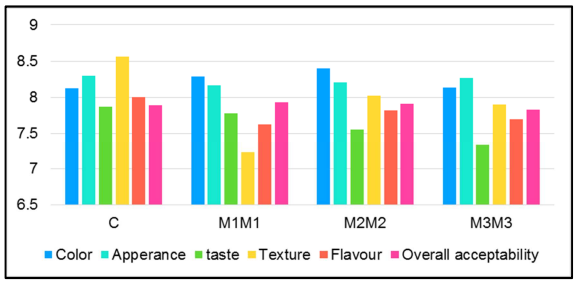

Fig. 10. Graph representing mean acceptability for *Murukku*.

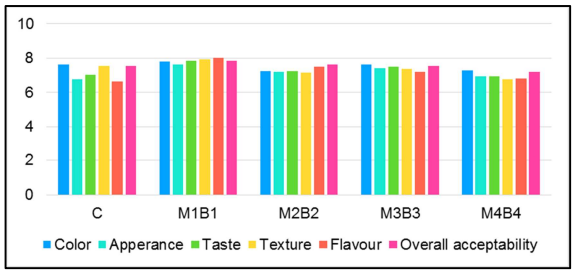

Fig. 11. Graph representing mean acceptability for *Burfi*.

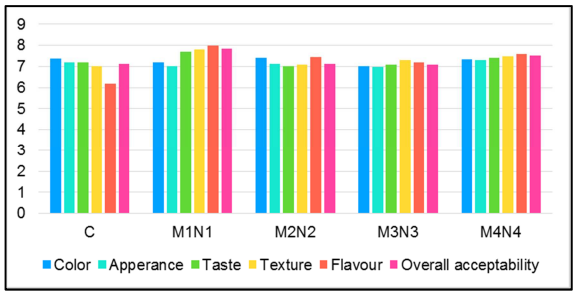

Fig. 12. Graph representing mean acceptability for *Noodles*.

Conduction of acceptability trials

Thirty people from several departments at Assam Downtown University made up a semi-trained panel that conducted acceptance testing. Scores were determined using a nine-point hedonic scale. The composite flour products were standardized for sensory characteristics. For the sensory evaluation of the composite millet flour products, four formulations were developed for each product with different compositions.

The trial was conducted to find out the acceptability of the products. The products were carefully prepared to have the correct taste, flavour, texture and consistency and were presented simultaneously at room temperature along with scorecards. The testing sessions took place in a lab that had good ventilation and lighting. The judges were in good health at the time of evaluation. The entire panellist was not in a habit of chewing tobacco, or smoking etc. The judges were allowed to be seated in chairs at the corner of the laboratory one at a time. The samples were served on identical plates and the proportions of the sample were adequate for testing. Water glasses were available for mouthwash. At the beginning of each testing session, the descriptive term for each quality to be evaluated was explained to the panel members. The panel members evaluated the samples on the basis of colour, appearance, taste, texture, flavour and overall acceptability. The scores for each quality were totalled and averaged.

To study the shelf life of developed products of the composite mix

Storage studies

The shelf life of developed products was studied by storing them in a ziplock polythene for a period of 15 days at room temperature. The packaging materials used for the shelf life study were polyethylene and polypropylene ziplock bag. The microbial count was done for the samples at day 0, day 5, day 10 and last at day 15.

Sensory evaluation

For the sensory evaluation stored *Bor Pitha*, *Murukku*, *Burfi*, and noodles were stored in packaging material *vide supra*. The products *Burfi*, *Bor Pitha* were evaluated on day 1, day 3 and day 5. The products *Murukku* and noodles were evaluated on day 1, day 5, day 11 and day 15. The panel members evaluated the samples on the basis of colour, appearance, taste, texture, flavour and overall acceptability. The scores for each quality were totaled and averaged.

Statistical analysis of data

The statistical methods were presented in the same tables, graphs, and other visual representations to determine whether the relationship between formulation qualities and the sensory response was likely to be true and not just the product of uncontrolled variance in reaction. All the data of chemical analysis were statistically analysed by Mean and Standard deviation**.**

Results and discussion

Determination of the proximate composition of composite flour

Table 5 shows the proximate results of various millet flours. Foxtail millet flour has the highest ash content of 1.04% and total energy of 395.40 kcal/100g. Moisture, protein and carbohydrate content of finger millet flour is highest i.e. 9.56%, 8.42% and 80.56% respectively. Fat content of proso millet flour is highest i.e. 8.71%.

Table 5. Proximate results

	Moisture	Ash	Protein	Fat	Carbohydrate	Total energy
Foxtail Millet	7.04%	1.04%	8.26%	5.54%	78.12%	395.40
Finger Millet	9.56%	0.76%	8.42%	0.7%	80.56%	362
Proso Millet	9.48%	0.69%	0.09%	8.71%	1.13%	365
Composite flour	8.61%	0.82%	8.38%	2.43%	79.02%	370.392

The proximate composition of foxtail millet showed similar results, with moisture content of 11.45%, ash content of 4.7%, fat content of 4.1%, protein content of 12.01%, crude fibre content of 7.60%, and carbohydrate content of 61.15%.[29].

According to a study, the percentages of moisture, total carbohydrate, protein, fat, fibre, and ash were, respectively, 7.50–11.75, 71.90–76.38, 6.7–8.0, 1.2–1.7, 3.1–3.8, and 3.1–3.8.30.[30] In a study it was found that mixed millet milk contained moisture 90.96±0.15, ash 0.35±0.16, protein 8.5±0.16, fat 0.74±0.15, fibre 0.9±0.15, carbohydrate 7.8±0.1.

Formulation of composite flour products

Proso millet (*Panicum miliaceum*), finger millet (*Eleusine coracana*) and foxtail millet (*Setaria italica*), along with urad dal flour, besan, ghee, and rice flour were used by practising various methods of formulation for the preparation of the products to enhance the quality, taste and flavour. The composite flour was developed into four different products i.e., *Bor Pitha, Murukku, Noodles*, and *Burfi.*

Sensory evaluation of the formulated products

Conduction of acceptability trial

For the sensory evaluation of the composite millet flour products, four formulations were developed for each product. Ingredients like salt, sugar, nuts, spices, and chilli flakes were added to different products to enhance the taste and flavour (Figs 13-16).

Fig.13. Different preparations of *Bor Pitha*

Fig. 14. Different preparations *Murukku.*

Fig. 15. Different preparations of *Burfi.*

Fig. 16. Different preparations of *Noodles.*

From Table 6, it can be observed that while considering the mean colour score of the 4 formulations of *Bor Pitha*, sample M3P3 got the

highest score of 7.81 and sample M2P2 got the lowest score of 7.2. In the case of appearance, M2P2 got the highest while M1P1 got the lowest. In the case of taste, M2P2 got the highest score of 8.22. The texture of M3P3 was the best and while M1P1 got the lowest score of 7.33. The flavour of sample M2P2 got the highest score of 7.96.

In the case of overall acceptability M4P4 got the highest score. During the acceptability trials, it was found that sample M2P2 got the highest score in sensory attributes. Therefore based on the acceptability of sensory attributes sample M2P2 was selected.

Table 6. Mean acceptability scores of formulated composite flour products.

Product developed	Formulation	Quality attributes					
		Color	Appearance	Taste	Texture	Flavor	Overall acceptability
Bor pitha	CP	7.66±0.99	7.43±0.77	7.6±0.77	7.5±0.77	7.6 ± 0.85	7.73 ± 0.74
	M1P1	7.2±0.92	7.26± 0.86	7.31±0.89	7.33±0.88	7.36 ± 0.89	7.36 ± 1.09
	M2P2	7.83 ±0.69	7.9±0.66	8.22±0.71	7.9±0.71	7.96 ± 0.75	8.10 ± 0.77
	M3P3	7.81 ± 0.43	7.7±0.83	8.16±0.83	8.03±0.71	7.93 ± 0.86	8.13 ± 0.73
	M4P4	7.8 ± 0.76	7. 63 ± 0.53	7. 41 ± 0.62	7.38 ± 0.34	7.31 ± 0.49	8.16 ± 0.92
Murukku	CM		8.30 ± 0.67	7.87 ± 0.83	8.56 ± 0.87	8 ±0.84	7.89 ± 0.19
	M1M1	8.29 ± 0.62	8.17 ± 0.63	7.78 ± 0.76	7.23 ± 0.96	7.63±0.78	7.93 ± 0.66
	M2M2	8.40 ± 0.64	8.21 ± 0.73	7.55 ± 0.91	8.02 ± 0.68	7.82±0.93	7.91 ± 0.97
	M3M3	8.13 ± 0.63	8.27 ± 0.76	7.33 ± 0.98	7.9 ± 0.92	7.70±0.90	7.83 ± 0.86
	M4M4	8.12 ± 0.79	7.99 ± 0.75	7.95 ± 0.86	8.67 ± 0.81	8.25 ± 0.79	8.37 ± 0.71
Burfi	CB	7.64 ± 1.78	6.77 ± 0.4	7.02 ± 0.64	7. 52 ± 0.71	6.65 ± 1.27	7.52 ± 0.83
	M1B1	7.79 ± 0.94	7.63 ± 0.99	7.86 ± 1.04	7.91 ± 1.01	8.03 ± 0.99	7.83 ± 0.92
	M2B2	7.26 ± 0.87	7.2 ± 1.08	7.24 ± 1.27	7.14 ± 1.17	7.48 ± 0.93	7.62 ± 0.69
	M3B3	7.63 ± 1.15	7.4 ± 1.2	7.48 ± 1.08	7.35 ± 1.31	7.21 ± 1.94	7.53 ± 1.05
	M4B4	7.27 ± 1.18	6.94 ± 1.48	6.95 ± 1.76	6.76± 1.23	6.81 ± 1.51	7.2 ± 1.26
Noodles	CN	7.39 ± 1.09	7.18 ± 0.73	7.2±1.39	7.03 ± 1.4	6.2 ± 0.76	7.12 ± 0.52
	M1N1	7.21 ± 0.81	7.01 ± 1.06	7.69 ± 0.92	7.8 ± 0.93	7.98 ± 0.89	7.84 ± 0.78
	M2N2	7.40 ± 0.89	7.11 ± 1.05	7 ± 1.32	7.1 ± 1.31	7.43 ± 1.23	7.11 ± 1.14
	M3N3	7.01 ± 1.21	6.97 ± 1.13	7.1 ± 1.16	7.3 ± 1.26	7.21 ± 1.11	7.07 ± 1.09
	M4N4	7.35 ± 1.44	7.3 ± 1.2	7.42 ± 1.44	7.5 ± 1.32	7.59 ± 1.13	7.53 ± 1.13

From Table 6, it can be observed that while considering the mean colour score of the 4 formulations of *Murukku*, sample M2M2 got the highest score of 8.40 and sample M4M4 got the lowest score of 8.11. In the case of appearance,cm got the highest while M4P4 got the lowest. In the case of taste, M4M4 got the highest score of 7.95. The texture of M4P4 was the best and while M1P1 got the lowest score of 7.33. The flavour of sample M4M4 got the highest score of 8.25. In the case of overall acceptability M4M4 got the highest score. During the acceptability of trials, it was found that sample M4M4 got the highest score in sensory attributes. Therefore based on the acceptability of the sensory attributes sample M2M2 was selected.

Also from Table 1, it can be observed that while considering the mean colour score of the 4 formulations of noodles, Sample M1N1 got the highest score of 7.81 and sample CN got the lowest score i.e. 7.2. In the case of appearance, M4N4 got the highest while M3N3 got the lowest. In the case of taste, M1N1 got the highest score of 8.22. The texture of M1N13 was the best and while CN got the lowest score of 7.33. The flavour of ample M2P2 got the highest score of 7.96. In the case of overall acceptability M4P4 got the highest score. During the acceptability trials, it was found that sample M1N1 got the highest score in sensory attributes. Therefore based on the acceptability of sensory attributes sample M1N1 was selected.

From Table 1, it can be observed that while considering the mean colour score of the 4 formulations of *Burfi*, sample M1B1 got the highest score of 8.21 and sample CB got the lowest score of 8.2. In the case of appearance, M4B4 got the highest while M2B2 got the lowest. In the case of taste, M1B1

got the highest score of 6.9. The texture of M1N13 was the best and while CB got the lowest score of 8.65. The flavour of ample M2B2 got the highest score of 8.3. In the case of overall acceptability M4B4 got the highest score. During the acceptability trials, it was found that sample M2B2 got the highest score in sensory attributes. Therefore based on the acceptability of sensory attributes sample M2B2 was selected.

To study the shelf life of the developed composite flour products

Organoleptic evaluation for sensory attributes-

For the sensory evaluation *Bor Pitha, Murukku*, Burfi, and noodles (Figs 17-20) previously stored in packaging material were evaluated. The products like *Burfi, Bor Pitha* were evaluated on day 1, day 3 and day 5. The products like *Murukku* and noodles were evaluated on day 1, day 5, day 11 and day 15. The panel members evaluated the samples on the basis of colour, appearance, taste, texture, flavour and overall acceptability. The scores for each quality were totalled and averaged. Certain changes that were seen during the organoleptic evaluation on various days over the storage period are mentioned below-

It was observed that on day 1 there was no change in the sensory attributes of *Bor Pitha*. On day 3 there was no change in colour or appearance, however, there was a noticeable change in taste, texture, flavour and overall acceptability with respective scores of 2.76, 5.32, 3.1 and 3.65. There was a foul smell in the product and hence was discarded from storage.

Burfi showed no changes in sensory attributes during day 1. On day 3 there was no change in colour, appearance, taste, or texture. However, on day 7, there was a noticeable change in taste, texture, flavour and overall acceptability with respective scores of 2.56, 4.06, 3.23 and 3.78. There was a foul smell in the product and hence was discarded from storage.

As for *Murukku*, It was observed that on day 1, day 5 and day 11, there was no change in its sensory attributes. The product maintained its original colour, flavour, texture and overall acceptability. However on day 15, it was observed that the texture was changed, it seemed to be damp due to the absorption of moisture and there was a slight change in flavour. The colour, appearance, taste, texture, flavour, and overall acceptability scores were found to be 8.40, 7.98, 6.55, 5.02, 6.82 and 6.91 respectively.

Lastly, for noodles, no change in sensory attributes was observed on day 1, day 5, day 11 and day 15. This may be because of less amount of moisture present in the product as it was sun-dried before storage.

Fig.17. Storage for *Bor Pitha*.

Fig. 18. Storage for *Murukku*

Fig. 19. Storage for *Noodles*.

Fig. 20. Storage for *Burfi*.

Conclusion and future scope

Millet, the super food, has superior nutritional qualities and has the potential to serve as an alternative staple food. Although millet used to be a crucial part of the Indian diet during the old times, it lost its importance with the passage of time. So the present study was undertaken to formulate and develop a composite flour mix using proso, finger and foxtail millets which were then used for the preparation of value-added products that can be prepared at commercial as well as household levels and their organoleptic quality, physiochemical property and shelf life evaluation were done. This study on proso, finger, and foxtail millet underscores their crucial importance in Assam and the wider North East region of India as the prepared food products hold special importance in Indian cuisine. These millets not only have deep cultural and traditional significance but also offer promising health and commercial prospects for the future.

By promoting the cultivation and consumption of these millets, Assam and North East India can enhance food security, diversify agricultural practices, and contribute to sustainable development. Additionally, these millets are packed with essential nutrients, dietary fibre, and antioxidants, providing numerous health benefits such as improved digestion, reduced risk of chronic diseases, and enhanced overall well-being. Furthermore, the increased cultivation of millet, preparation of value-added products and commercialization can have positive economic implications, generating income for farmers and thereby boosting the local economy as a whole. Further studies can be conducted to do complete nutritional profiling of millet composite flour. Human trials can also be conducted to study their effect. Various other products can be prepared using millet composite flour and commercialization of these products can be done which may be helpful in generating farmer's income and boosting the local economy.

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Conflict of interest

The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Baburao KK, Kamble DK, Patange DD, Yadav MM, Londhe-Pati PB. 2019. Process standardization for preparation of green chickpea (*Cicer arietinum* L.) Burfi. The Pharma Innovation Journal **8(11),** 201-206.

Biradar VM, Kumargouda V, Suresha KB, Mohithkumar GV, Shobha D. 2023. Physical, functional properties and nutritional composition of Kodo millet and Red rice. The Pharma Innovation Journal **12(4),** 1063-1065.

Choudhari AK, Khan TN. 2023. Development and nutritive evaluation of foxtail millet (*Setaria italic* L.) biscuits. The Pharma Innovation Journal **12(2),** 1992-1994. https://dx.doi.org/10.22271/tpi

Das S, Khound R, Santra M, Santra DK. 2019. Beyond bird feed: Proso millet for human health and environment. Agriculture **9(3),** 64. https://doi.org/10.3390/agriculture9030064

Gogoi M, Pathok P, Bharadwaz PJ. 2022**.** Status of area, production and productivity of fruit crops (Major and indigenous) of North East India, with special reference to Assam. The Pharma Innovation **11(3),** 1556-1561.

Harini SJ, Chandara Meenu A, Sneka S. 2023. Formulation And Evaluation Of Mixed Millet Paneer. European Chemical Bulletin **12(Si6),** 6091-6102.

Hariprasanna K. 2016. Foxtail millet: Nutritional importance and cultivation aspects. Indian Farming **65(12).**

Hymavathi TV, Thejasri V, Roberts TP. 2019. Enhancing cooking, sensory and nutritional quality of finger millet noodles through incorporation of hydrocolloids. International Journal of Chemical Studies **7(2),** 877-881.

Jain V. 2020. Sweets as traditional medicine in winter season: An ethnobotanical study in Udaipur city, India. Ethnobotany Research and Applications **20,**1-17.

Jyoti S, Sangwan V. 2022. Nutritional composition and sensory characteristics of Burfi supplemented with spinach leaves powder. The Pharma Innovation **4,** 766-770.

Kumari, B., Vibhute, B. P., & Solanki, H. 2022. "PITHA" the heritage food of Odisha during the traditional festival: A scientific studies on its nutraceutical and nutritional analysis. Research and Reviews: Journal of Environmental Sciences **4(3),** 1-11. https://doi.org/10.5281/zenodo.7109739

Li Q, Liu S, Obadi M, Jiang Y, Zhao F, Jiang S, Xu B. 2020. The impact of starch degradation induced by pre-gelatinization treatment on the quality of noodles. Food chemistry **302,** 125267. https://doi.org/10.1016/j.foodchem.2019.125267

Londhe D, Gundeti MS. 2023. Perspective on-'Millet for Health'initiatives by Ayush Institutes across India based on the Hon'ble Prime Minister's Millet-promotion call through Mann ki Baat. Journal of Research in Ayurvedic Sciences **7(5),** 41. DOI: 10.4103/ jras.jras_108_23

Maharajan T, Antony Ceasar S, Ajeesh Krishna TP, Ignacimuthu S. 2021. Finger millet [*Eleusine coracana* (L.) Gaertn]: an orphan crop with a potential to alleviate the calcium deficiency in the semi-arid tropics of Asia and Africa. Frontiers in Sustainable Food Systems **5,** 684447.

Nakarani UM, Singh D, Suthar KP, Karmakar N, Faldu P, Patil HE. 2021. Nutritional and phytochemical profiling of nutracereal finger millet (*Eleusine coracana* L.) genotypes. Food Chemistry **341,** 128271.

Namitha MY, Chavan UD, Kotecha PM, Lande SB. 2019. Studies on nutritional and sensory qualities of foxtail millet chakli. Studies **4(5).**

Parvin R, Farzana T, Mohajan S, Rahman H, Rahman SS. 2020. Quality improvement of noodles with mushroom fortified and its comparison with local branded noodles. NFS journal **20,** 37-42. https://doi.org/10.1016/j.nfs.2020.07.002

Peryam DR, Pilgrim FJ. 1957. Hedonic scale method of measuring food preferences. Food technology.

Sachdev N, Goomer S, Singh LR. 2021. Foxtail millet: a potential crop to meet future demand scenario for alternative sustainable protein. Journal of the Science of Food and Agriculture **101(3),** 831-842. https://doi.org/10.1002/jsfa.10716

Saleh AS, Zhang Q, Chen J, Shen Q. 2013. Millet grains: nutritional quality, processing, and potential health benefits. Comprehensive reviews in food science and food safety **12(3),** 281-295. https://doi.org/10.1111/1541-4337.12012

Sharat DD, Gokhale D. 2022. Nutritional Impact of Millet-based Foods on Pregnant and Nursing Women from Anganwadi Centers in Mahabubnagar. International Journal of Nutrition, Pharmacology, Neurological Diseases **12(2),** 66-71.

Sharika D. 2020. Development, nutritional evaluation and enhancement of functional characteristics of multigrain noodles incorporated by Jamun seed powder**.** IJCS **8(6),** 2453-2457. https://doi.org/10.22271/chemi.2020.v8.i6ai.11141

Stone H, Bleibaum RN, Thomas HA. 2020. Sensory evaluation practices. Academic press.

Tadele Z. 2019. Orphan crops: their importance and the urgency of improvement. Planta **250,** 677-694.

Vudugula G, Waghray K. 2018. Development of Low calorie cupcakes using Coconut Milk. Development **3(2)**.

Wambi W, Otienno G, Tumwesigye W, Mulumba J. 2021. Genetic and genomic resources for finger millet improvement: opportunities for advancing climate-smart agriculture. Journal of Crop Improvement **35(2),** 204-233. https://doi.org/10. 1080/15427528.2020.1808133

Xiang J, Yuan Y, Du ., Zhang Y, Li C, Beta T. 2023. Modification on phenolic profiles and enhancement of antioxidant activity of proso millets during germination. Food Chemistry: X **18**, 100628. https://doi.org/10.1016/j.fochx.2023.100628